



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DEVELOPMENT OF EEG EPILEPSY RECOGNITION  
SYSTEM USING ARTIFICIAL NEURAL NETWORK**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours.

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Sesi Pengajian: 2021

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## ABSTRAK

Epilepsi diklasifikasikan sebagai salah satu gangguan berkaitan otak yang mempengaruhi keseluruhan sistem saraf otak dan ini disebabkan oleh gelombang otak yang mengalami perubahan voltan berfrekuensi tinggi, atau disebut sebagai sawan. Penyakit ini adalah salah satu pergerakan tidak terkawal yang dilakukan oleh pesakit epilepsi tanpa sedar. Oleh itu, kajian tesis ini adalah untuk membangunkan sistem pengecaman *epilepsy* dengan menggunakan Rangkaian Neural Buatan (ANN). Teknik Rangkaian *Neural Cascade-forward* digunakan dalam pembelajaran mesin sebagai alat utama untuk melaksanakan proses persis otak manusia. Sistem ini diilhamkan dengan bertujuan untuk mencipta kembali cara pemikiran otak manusia. Tesis ini menggunakan Rangkaian *Neural Cascade-forward* yang sangat mirip dengan Rangkaian *Neural Feed-Forward* dan kemudian prosedur pengecaman epilepsi ini dilaksanakan dengan menggunakan perisian MATLAB. Selain itu, kajian ini juga menggunakan elektroensefalogram (EEG) yang kemudiannya digunakan untuk mendiagnosis dan mengakses aktiviti didalam otak manusia dengan menggunakan set data yang diperolehi dari University of Bonn (UBonn), yang telah banyak digunakan oleh penyelidik lain mengenai kajian epilepsi ini. Penderia MindLink EEG digunakan untuk memperoleh data luaran dari isyarat EEG, yang kemudian diperlukan untuk menguji di jaringan saraf. Hasilnya, sistem ini berjaya dilaksanakan dengan 79.4% untuk ketepatan keseluruhan dengan latihan, pengesahan dan pengujian secara berurutan dengan memperoleh 79.4%, 88.0% dan 70.3%.

## ABSTRACT

Epilepsy classified as one of the brain-related disorders affecting the entire brain nervous system and characterized by the high-frequency and high-voltage brain waves, which called as a seizure. This disease recognized as one of the uncontrollable movements made by the epilepsy patients during an outbreak which can cause consciousness and convulsion. Consequently, this thesis studies are to develop EEG Epilepsy Recognition System using Artificial Neural Network (ANN). Cascade-Forward Neural Network technique is used as their primary tools which their system invented to execute a process like a human brain. This brain-inspired system which meant to recreate the way human brains thinks. This thesis uses Cascade-forward Neural Network, which is quite similar to the Feed-forward Neural Networks approach and proposes the epilepsy recognition procedure implemented by using MATLAB software. Additionally, this study also used the Electroencephalogram (EEG) signal which then used to diagnose and accessing human brain activity and disorder by using the dataset obtained from University of Bonn (UBonn), which has been widely used by other researchers regarding epilepsy studies. The MindLink EEG Sensor is used to obtained external data of the EEG signal, which then needed to test in the neural network. As for results, this system successfully carried out with 79.4% for overall accuracy with training, validation and testing sequentially acquire 79.4%, 88.0% and 70.3%.

## DEDICATION

This thesis is dedicated to Yahya Bin Yusof and Maszalinah Binti Ruslan, my beloved parents for their constant love, encouragement, and inspiration. To my supervisor Encik Khairul Azha Bin A. Aziz who never giving up to taught and guide me to complete my thesis. To my beloved siblings Masliya Binti Yahya, Yamim Bin Yahya and Marita Binti Yahya who always keep supporting me. To my best friend, Ainnur Annisa Binti Noor Izan, thank you for always be there for me.





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## LIST OF SYMBOLS

$\mu\text{V}$	Microvolts
$\alpha$	Alpha
$\beta$	Beta
$\gamma$	Gamma
$\Delta$	Delta
$\theta$	Theta
<b>Hz</b>	Hertz
<b>V</b>	Volt
<b>dB</b>	Daubechies
$\psi$	Wavelet coefficients
$\pi$	Tau
<b>VCC</b>	Voltage Common Collector
<b>GND</b>	Ground
<b>RX</b>	Receiver
<b>TX</b>	Transmitter
$a$	Scaling Parameter
$b$	Location of the Parameter
<b>%</b>	Percentage

## LIST OF ABBREVIATIONS

<b>EEG</b>	Electroencephalogram
<b>MIT</b>	Massachusetts Institute of Technology
<b>CNN</b>	Convolutional Neural Network
<b>CHB</b>	Children's Hospital Boston
<b>CWT</b>	Continuous Wavelet Transform
<b>BoW</b>	Bags-of-Words
<b>SVM</b>	Support Vector Machine
<b>DWT</b>	Discrete Wavelet Transform
<b>FFT</b>	Fast Fourier Transform
<b>AR</b>	Autoregressive or Autoregression
<b>MLPNN</b>	Multilayer Perceptron Neural Network
<b>ANFIS</b>	Adaptive Neuro-Fuzzy Interference System
<b>KDD</b>	Knowledge Discovery in Database
<b>RNN</b>	Recurrent Neural Network
<b>LSTM</b>	Long-Short-Term Memory
<b>GRU</b>	Gated-Recurrent Unit
<b>STFT</b>	Short-time Fourier Transform
<b>WT</b>	Wavelet Transform
<b>GPS</b>	Global Positioning System
<b>ANN</b>	Artificial Neural Network
<b>UBonn</b>	University of Bonn

<b>MATLAB</b>	Matrix Laboratory
<b>GUI</b>	Graphical User Interface
<b>2D</b>	2-Dimensional
<b>WT</b>	Wavelet Transform
<b>DNA</b>	Deoxyribonucleic acid
<b>FC</b>	Fully Connected Layer
<b>ASCII</b>	American Standard Code for Information Interchange
<b>PLX-DAQ</b>	Parallax Data Acquisition
<b>IDE</b>	Integrated Development Environment
<b>ROC</b>	Receiver Operating Characteristic
<b>perf</b>	Performance
<b>COMM</b>	Component Object Model
<b>USB</b>	Universal Serial Bus
<b>Std</b>	Standard Deviation
<b>IoT</b>	Internet of Things
<b>AIS</b>	Artificial Immune Network

# CHAPTER 1

## INTRODUCTION

### 1.1 Overview

In reality, this chapter actually explain about the description for a project summary. The contents under this chapter is including Project Background, Statement of the Purposes, Problem Statement and Project Scope. By going through this part, the reader should be able to understand the core concept of this thesis.

### 1.2 Project Background

Epilepsy is classified as one of the brain-related disorders affecting the entire brain nervous system and it is characterized by the high-frequency and high-voltage brain waves which is called as seizure. These seizure puts patients at a higher risk for injuries such as falls, head injuries, scrape, burns, and many others. This is due to abrupt seizure and leaving the patient without any further notice. This Epilepsy condition affects 50 million people all around the world and mostly 90% of the epilepsy patients live in countries looking to be advance and around three of fourth of them are unable to get the proper and suitable treatment (Hekim, 2012). Until now there is still no cure for the disease and only can be treated with medications and surgery.

Electroencephalogram (EEG) is one of the devices or instruments that specially measures the electrical activities generated by firing of neurons along the scalp within the brain. EEG is a non-invasive, cost effective, well-established, and accurate procedure used to diagnose brain-related disorders such as epilepsy, autism, brain tumours and

depression. EEG reads changes in the brain voltage between electrodes which are positioned on some crucial points of the patient's head with some help of proper mechanical and electrical support. Hence, the EEG signal data collected is sent to the main EEG system and saves the signals produced (Alqatawneh *et al.*, 2019).

Epilepsy raw database is obtained from the Department of Epileptology at University of Bonn in Germany (UBonn). The EEG raw dataset then is analysed completely by using Discrete Wavelet Transform (DWT). The DWT then is separated into 8 sub-band frequencies which is delta, theta, low alpha, high alpha, low beta, high beta, high gamma and low gamma. According to the psychological studies, frequency which is more than 60 Hz is regarded as noise and can be neglected (Abdullah, Rahim and Ibrahim, 2012). The method of classifying Artificial Neural Network (ANN) is used to do mathematical processes such as calculation, decision-making, and learning. Based on the human biological nervous system, this model known to be mechanisms for ANN the simulation of biological neural network (Jaafar, Mohamood and Mahdi, 2018).

ANNs are commonly used in the identification of signal groups in many biomedical signal analyses, as they have a greater predictive ability than the techniques of signal analysis. Therefore, they provide useful advice for making a medical diagnosis decision (Hekim, 2012). In this study, we demonstrate analysis of EEG signals using ANN by MATLAB neural network toolbox. The main purpose of this paper to illustrate the potential use of ANN to classify between normal persons and those who suffer from epilepsy by evaluating the EEG parameter data.